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DECENTRALIZED ELECTRICITY SOLUTIONS: innovation in essential services is no substitute for policy

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The African electricity sector has undergone profound change in recent years. Off-grid solar solutions are now very much part of the new-look industry. But lack of coordination between authorities and, crucially, the uncertainty that persists surrounding the long-term future of off-grid installations in the face of the stated desire to extend national power grids, combine to slow the uptake of off-grid solutions. This situation favors certain intermediaries in the market, such as startups and small-scale resellers of solar-powered items. Whereas some rely on quality of customer service and advanced technologies (modular battery solar home systems, or SHS, and interconnections between individual solar kits), others exist to meet demand for low-cost solar-powered items. Questions arise concerning how public policies and market mechanisms interact. Current regulations lack a holistic vision and joined-up thinking, meaning it is not yet realistic to think in terms of hybridization.

INTRODUCTION

Technological innovations and new off-grid solutions are leading many experts to predict an electrical revolution in Sub-Saharan Africa, where 620 million people remain without access to electricity (Africa Progress Panel, 2017). Almost 26 million African households (around 100 million people) already have access to electricity via decentralized forms of energy production (IRENA, 2016) and new projects are springing up daily across the continent (Jacquemot and Reboulet, 2017). However, reports from the field reveal contrasting processes at work. Although governments always claim to embrace innovation and enact legislation to promote it, government actions remain inadequate and at times inappropriate. Simultaneously, private sector players are actively creating commercial offers that take advantage of available new technologies, but without ever making universal provision a reality. The diversity of emerging configurations for electrical supply and the territories concerned make it difficult to define conditions for an energy transition capable of delivering access to electricity that is technically reliable, economically viable and socially acceptable.

This article examines two case studies, from Tanzania and Senegal.¹ It sets out to examine the processes of change and the roles of market mechanisms and public policy-making. It then looks at the social and spatial impacts of the deployment of off-grid solutions, identifying the population groups and territories that these new offers appear to benefit above others.

¹ Data from qualitative surveys conducted in 2018-19 by Emmanuelle Guillou for a doctoral thesis.

PUBLIC ACTION AND TECHNOLOGICAL INNOVATION

In every country of Sub-Saharan Africa, national actors are incorporating technological innovations and decentralized solutions into their electrification policies and programs. These are built on a diverse range of contract arrangements with private partners and they generally differentiate between urban and rural localities, for which different sociotechnical offers are designed, that reflect the dominant representations of the territorially based needs and social functions of electricity (Jaglin, 2019).

In Senegal and Tanzania, successive reforms of the electricity sector have led to spatial differentiation in electrification modes, with the creation of specialized agencies for rural zones and, in recent years, the promotion of access via off-grid solutions.

TECHNOLOGICAL INNOVATION AND ROLLING OUT ELECTRICITY TO RURAL AREAS

In both countries, the 2000s were marked by a succession of institutional reforms intended to deliver “access to affordable, reliable, sustainable and modern energy for all” by 2030 (SDG 7).

In Senegal, the 1998 reform of the electricity sector led to the creation of a Senegalese agency for rural electrification

(ASER) and an industry regulator (CRSE). Similarly, the 2005 reform in Tanzania created the Rural Electrification Agency (REA), and the Energy and Water Utilities Regulatory Authority (EWURA), the industry watchdog. Initially controlled by major national operators (Sénélec in Senegal and TANESCO in Tanzania) or international operators (concession operators in Senegal), since the mid-2000s rural electrification has been open to small private operators. Supported by lower administrative hurdles and new financing sources, this wave of liberalization favored decentralized solutions: mini-grids and solar home systems (SHS).

In both countries, rural electrification using decentralized solutions is not an innovation in itself. In Tanzania, for instance, hydropower mini-grids were set up in the 1950s and '60s by large agricultural or industrial companies or by missionaries. More recent initiatives are, however, characterized by two innovations. On the one hand, governments construct an enabling framework coupled to incentive measures; on the other, there is a progressive integration of technological advances (smart meters, prepayment systems, massive use of photovoltaic solar, etc.) enabled by falling costs and rapid uptake. Against this background, two trends emerge following a comparative analysis of national policies.

The climate of uncertainty is heightened in both countries by the ambiguity of the government's position on the future of decentralized solutions

SPATIALIZATION OF OFFERS FOR ACCESS TO ELECTRICITY



Junction point between the Sénélec medium voltage grid and the low voltage network operated by NSRESIF, village of Diaglé



Site of the Kéré mini power plant, operated by SALENSOL



SHS installed by a household in the village of Darou Djaji Guéyène, operated by NSRESIF

Emmanuelle Guillou - Source: field observations

Figure 1

The Senegalese approach is prescriptive, classifying rural areas on the basis of geographical, socioeconomic and technical criteria (distance from the grid) and then inviting tenders from actors of various types. This means that a village located close to an existing national infrastructure will be connected, whereas a densely populated village in a more out of the way area will be fitted with a mini-grid, and a sparsely populated village in a remote area will be targeted for SHS-type solutions. This way of organizing the various technical solutions between villages, and even within the same village, institutes a spatial hierarchy between levels of service, from the most basic (lighting and small-device charging with SHS) to the most complete (usage via a grid connection).

In Tanzania, the approach is more incitement-led, consisting of promoting the development of certain supply models through differentiated subsidy payments according to the technologies used by developers of decentralized solutions. But this style of intervention has evolved to reflect technological advances and political choices.² The Rural Electrification Agency (REA) supported the distribution of “solar gadgets” (small solar torches, batteries, etc.) between 2007 and 2012, then favored SHS for community facilities as of 2010, before promoting mini-grids in 2014. But, in 2014, the REA decided to stop making its aid conditional on a type of technology and to think instead in terms of access: from level 1 (SHS electrification) to level 5 (solution supplying a grid-equivalent service). A separate budgetary envelope is defined for each level. To a certain extent, the REA is thus able to indirectly influence the type of solution deployed in a territory as well as the type of supplier. For instance, operators able to provide level 5 access are inevitably major companies with a well-established activity in the territory.

In both countries, incorporation of technological innovations is seen as necessary for the viability of off-grid electrification solutions. The first step is incorporating innovations that facilitate the use of solar energy: using a local energy source allows to put aside the question of the cost of transmitting electricity to isolated areas; project owners are eligible for international funds and subsidies to promote “clean” energies; reduced production costs improve the chances that the service will be profitable. There is also an emphasis on using digital technologies, such as smart meters, that deliver lower operating costs via remote monitoring, and prepayment solutions that are more appropriate for customers with variable incomes.

POLITICAL AND REGULATORY FRAMEWORKS FOR DEPLOYMENT: CREATING UNCERTAINTY

On paper, national policies in place since the late 1990s put considerable emphasis on decentralized solutions and technical innovations. In reality, deployment of national strategies is hampered by states’ patchy financial and

organizational capacities, resulting in actions that are uncoordinated, inadequate and at times inappropriate.

The large number of principals and the lack of coordinated public action make the situation hard to read for developers of decentralized solutions and consumers. In Senegal, national agencies for rural electrification mushroomed in the years after 2010 as a result of policies seeking to promote renewable energies. A National Eco-village Agency and a National Renewable Energies Agency were created in addition to ASER and Sénélec. Besides

the programs run by these agencies, the ministry of Energy controls the Emergency Community Development Program. Lack of national coordination between these multiple decision-making hubs leads to overlapping programs with reduced accountability. In Tanzania, all cases touching on the rural electricity sector are theoretically managed by the

REA. In practice, mini-grid operators deplore the lack of coordination of electrification projects as a whole and the absence of precise information about plans for extending the national power grid. It is not unusual for them to discover that the grid is about to arrive, just months after installing their equipment in a locality. This lack of certainty has a dissuasive effect on investors, who are increasingly wary, and it leads to more and more “grey areas” too close to the main grid to convince off-grid solution operators to set up, but too distant to be connected quickly.

For a decentralized system operator to commit depends also on the fate of the installation once the locality is connected to the national grid. The legislation differs in this regard. In Senegal, the law requires mini-grid operators to withdraw under all circumstances, which does nothing to encourage investment to expand facilities and leads to inadequate capacity at many mini power plants. The main rural electrification program further embeds this restrictive approach to rural power, for example by installing systems that cut the supply once a daily quota is exceeded. Mini-grid operators justify the installation of these mechanisms by the need to control and ration the amount of electricity used because of limited power plant capacity. In this case technical innovations are being used paradoxically – facilitating access while limiting usage to essential functions only. These practices lead to two-tier electrification, with differences between people connected to the Sénélec grid and users of off-grid solutions, who are restricted by under-sized installations and lack of investment. By reinforcing consumers’ general dissatisfaction, this situation accentuates a general mistrust regarding solar technologies among those surveyed, equating it to a form of provisional pre-electrification, and there is a clear preference for a conventional grid connection. Once a grid extension seems probable, some villagers prefer to abandon alternative forms of electrification for fear of being ineligible for a Sénélec connection.

Technology alone is not sufficient to promote a successful policy for access to essential services

² Interview with a REA manager responsible for developing the electricity and technology market, October 2 2019, Dodoma (Tanzania).

In Tanzania, the national grid does not enjoy a territorial monopoly and current legislation allows a local operator to remain in a village connected by TANESCO. But there are other factors at play. Better-off users may move away from mini-grids because of high tariffs, whereas poorer users comprise a captive client base in the absence of subsidies for a connection to the national grid. Faced with lower profitability caused by the (partial) loss of larger users, mini-grid operators can also be tempted to pull out of a village, disconnecting households that rely on it exclusively. Finally, the law allows grid feed-in for mini-grids with a capacity of 0.1 to 10 MW, and some operators have used this as an opportunity to stabilize their business model by selling their production surplus to the national operator, which provides demand that is both high and relatively stable.

More noticeable in Senegal than in Tanzania, the climate of uncertainty is heightened in both countries by the ambiguity of the government's position on the future of decentralized solutions. On the one hand, they encourage and subsidize the entry of private actors into the market as a way to rapidly improve access to electricity. On the other hand, these incentives coexist alongside with a political discourse that stresses the goal of connecting the entire country to the electricity grid. Although not explicitly stated, the scenario considered relies on a linear transition leading to residual off-grid electrification in areas that are too isolated or insufficiently cost-effective. Yet, technically and financially, this scenario seems barely credible in the short or medium term.

DIVERSITY OF PRODUCTS SOLD BY PRIVATE ACTORS IN SENEGAL AND TANZANIA



SHS sold in a store in Kaolack, Senegal



Energy kiosk fitted with a mini solar power plant in Komolo village, Tanzania



Photovoltaic solar panels sold by a hardware store in Kaolack, Senegal



Local outlets distributing Sun King products in a peri-urban area of Arusha, Tanzania



Small solar-powered items sold on the market in Kaolack, Senegal



Display models showing the range of Sun King products at the company head office, Arusha, Tanzania

Emmanuelle Guillou - Source: field observations

Figure 2

NEW MARKETS CAPTURED BY POORLY REGULATED PRIVATE ACTORS

Due to this combination of regulatory incentives with restrictions, public action leads to contradictory relationships with technical innovations and new decentralized installations. Even so, these relationships only very partially reflect the changes under way. To understand how technological innovations incorporated into decentralized mechanisms for access to electricity are disseminated and appropriated, it is necessary to examine the entrepreneurs and intermediaries active in the market, as they also take ownership of these innovations to develop new offers targeting specific customer segments.

DEFICIENCIES IN THE PUBLIC ELECTRICITY SERVICE: BOON FOR COMMERCIAL ACTORS

There are numerous more or less formal actors in the off-grid electricity sector, with a highly diverse range of structures, resources and networks.

A first category includes overseas startups, often from Europe or the USA, and specialist retail outlets that have sprung up in all the major urban centers. These businesses generally distribute individual solar kits, or install and operate solar or hybrid mini-grids, or both. Most of them do more than just supply electricity, trying to stand out from their competitors and the national operator by diversifying their line-up of products and services: credit sale of electrical appliances to households and small businesses, creation of Wi-Fi zones in villages, installing public lighting free of charge, supporting village entrepreneurs who want to launch new activities, aftersales services, etc.

The second category includes small stores and traveling resellers. These traders tend to focus on the sale of photovoltaic solar panels, SHS and small solar-powered items, often imported from China and sold at prices attractive to customers with only modest incomes. Most of these are new to the trade, which they combine with other types of commercial activity. They do not offer credit and provide no guarantees, aftersales support or installation services.

These off-grid solutions attract two customer segments.

On the one hand, residents of rural areas not connected to the national grid, a group targeted as a priority by private actors in the first category. Given the limitations of public action for rural electrification, these actors have developed commercial strategies focusing on three key factors: proximity (setting up as close as possible to customers), customer service (delivery, home installation, guarantees, technical support), and flexibility (large range of solar equipment, extensive choice of payment options). The startups adopted pay-as-you-go and mobile payment from the outset, by establishing partnerships with national cellphone operators. And the equipment offered is ever more closely aligned with customers' real needs: in Senegal, a company called Ilemel sells a modular SHS that

allows batteries to be added directly to the basic model, increasing the power available, and Sud Solar claims to be considering an SHS-nano-grid hybrid system that allows progressive interconnection of individual solar kits installed in villages it serves.

On the other hand, these commercial practices, coupled with technical innovations, attract to off-grid solutions other customers who are or feel excluded by public policies. Included in this group are people already connected to the grid, often in towns and cities, who see these new electricity services as an alternative to a patchy and deficient national grid. In Senegal and Tanzania, more and more households are fitting photovoltaic solar panels as a back-up or to reduce their electricity bills. In Tanzania, some industrial and agricultural businesses are setting up hydropower mini-grids either as a standby or primary source of electricity where this appears more reliable and cheaper once the upfront investment is made. The emergence of this second group of customers is a boon for distributors as it allows them to consolidate their business models by serving a solvent customer segment. Companies like Zola, a well-established company in Tanzania, have even gradually developed specific products targeting this new type of customer: these are more costly but allow the connection of more power-hungry household appliances.

REGULATION NEEDED

The spread of these decentralized solutions for access to electricity has not been met with sufficient and appropriate regulatory responses. Variable oversight of the different forms of off-grid electricity supply is evidence of the slow pace of public action compared to the pace of changes in the market.

Although mini-grids are controlled by national regulators that deliver production and distribution licenses and set prices, distributors of solar equipment are not required to obey technical standards and are free to sell whatever they want. In Senegal, despite protests from rural electrification concession operators and some mini-grid operators, the government has opted for a *laissez-faire* policy to avoid hobbling the activities of private operators, whose investments are indispensable. In Tanzania, the lack of any regulation for competition between authorized companies and informal small traders led several formal companies in Arusha to close down.³

Deficiencies in regulatory frameworks favor the emergence of informal methods of regulation and opportunistic business practices. Informal regulations also tend to mirror existing balances of power and entrench the interests of dominant actors. In Tanzania, for example, in a peri-urban area east of Arusha, the national regulator allowed a large-scale farmer to connect villages to the hydropower mini-grid built for the farm and to sell electricity at a price lower than that charged by TANESCO. Feeling threatened by this

³ Interviews with authorized solar equipment traders, October 2019, Arusha (Tanzania).

alternative offer, the national operator then pressured the competitor to prevent any extension of the mini-grid beyond the farm limits.

CONCLUSION

Technical innovations and initiatives based on massive use of renewable energies are cropping up all over Africa, where the electricity sector is undergoing profound transformation, but without as yet offering any guarantees on universal provision of essential electricity services. This is caused by stereotypes about the electricity needs of rural areas that form the basis of much public policy-making and result in normative conceptions of the potential of off-grid solutions. As their deployment is reserved for certain types of locality or population group, who are in turn subject to uncertainties about timeframes and types of installation, preferences for a connection to the conventional power grid persist.

Meanwhile, capitalizing on opportunities and expectations created by these overly restrictive strategies, private actors supply new market-led solutions adapted to suit various solvent customer segments. Flexible and responsive, these initiatives produce a wider range of products and at prices that are more affordable for a greater number of people. But in the absence of a holistic overview of these evolutions, public regulations fail to get to grips with either the range of initiatives, private in particular, or the resultant mixture of overlapping methods for gaining access to electricity. And this undermines the results. First, the lack of joined-up thinking means some measures discourage initiatives by private actors, who are unwilling to invest in a climate of uncertainty. Even as pragmatic public action on the ground assists the deployment of decentralized solutions, political messaging and national regulatory frameworks continue to espouse the ideal of universal electrification delivered via the national grid. Although the term “pro-poor” is often quoted in the literature when describing individual solar solutions, these remain unaffordable for whole sections of the population (Bensch *et al.*, 2016). The beneficiaries in the rural world are not, in fact, the poorest, and some of the commercial effort is concentrated on consumers in urban areas. This leads to inequalities and new electrical divides, reflected in the contrasting levels of development seen in no-service grey zones compared to zones where many different solutions are available to people who already have a grid connection.

Technology alone is not sufficient to promote a successful policy for access to essential services. In the countries studied, as in many other countries of Sub-Saharan Africa, compartmentalized policies for rural electrification and overly restrictive visions of energy transition inhibit an understanding of all the forces at play and their impacts on hybridization processes (Jaglin, 2019). This also means that the need for socio-spatial regulation of inequalities is being overlooked. In the absence of overall coordination,

the mechanisms used by the various actors to offer decentralized solutions lead to a segmented service, not to a policy delivering justice in terms of access to electricity. This will not come about through technical innovation alone. It is first and foremost a question of political choices.

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